Claims

[c1] 1. A cooling gas ventilation circuit for an end winding of a rotary machine having a rotor, a plurality of radial slots provided in said rotor, and a plurality of coils respectively seated in said radial slots, said coils each comprising a plurality of radially stacked turns, said coils extending beyond a pole face of the rotor to form an end winding, cavities being defined between adjacent pairs of said coils, said ventilation circuit comprising:

a cooling gas passage defined in at least one turn of each said coil of said end winding, said cooling gas passage extending from an inlet port in communication with the cavity on one longitudinal side of said turn to one of (1) a radial chimney defined through a plurality of the turns of the coil within said respective radial slot and (2) an exit port defined on the other longitudinal side of said turn, said cooling gas passage extending along at least a portion of the longitudinal extent of said turn; and

wherein at least a portion of a surface of said cooling gas passage is knurled so as to have a non-planar surface profile for enhanced heat transfer.

[c2] 2. A cooling gas ventilation circuit according to claim 1, wherein said passage comprises a groove that is generally V-shaped in vertical cross-section.

[c3] 3. A cooling gas ventilation circuit according to claim 1, wherein said knurled surface comprises a plurality of ribs.

[c4] 4. A cooling gas ventilation circuit according to claim 3, wherein said ribs are generally V-shaped having an apex and first and second legs, each said leg being defined at an angle with respect to a cooling gas flow direction.

[c5] 5. A cooling gas ventilation circuit according to claim 4, wherein said angle is between about 45 ° and 90 ° .

[c6] 6. A cooling gas ventilation circuit according to claim 1, wherein said knurled surface comprises a dimpled surface.

[c7] 7. A cooling gas ventilation circuit according to claim 6, wherein said dimples are substantially hemispherically shaped.

[c8] 8. A cooling gas ventilation circuit according to claim 6, wherein said dimples are teardrop shaped, having a rounded end and a pointed end, said pointed end being the downstream end of the dimple with respect to a flow direction of said cooling air.

[c9] 9. A cooling gas ventilation circuit according to claim 1, wherein said passage is non-linearly disposed along said turn of said coil.

[c10] 10. A cooling gas ventilation circuit according to claim 9, wherein said passage defines a wavy cooling path along a direction of cooling gas flow.

[c11] 11. A cooling gas ventilation circuit according to claim 10, wherein walls of said passage are sine wave shaped.

[c12] 12. A cooling gas ventilation circuit according to claim 11, wherein said wave shaped walls define a groove of substantially constant width.

[c13] 13. The cooling gas ventilation circuit of claim 1, wherein said inlet port of said cooling passage is inclined to the respective turn longitudinal side face.

[c14] 14. The cooling gas ventilation circuit of claim 1, wherein said cooling passage comprises a groove defined in a radially facing surface of said turn.

[c15] 15. The cooling gas ventilation circuit of claim 14, wherein said groove is defined in the radially upper face of said turn.

[c16] 16. A cooling gas ventilation circuit for an end winding of a rotary machine having a rotor, a plurality of radial slots provided in said rotor, and a plurality of coils respectively seated in said radial slots, said coils each comprising a plurality of radially stacked turns, said coils extending beyond a pole face of the rotor to form an end winding, cavities being defined between adjacent pairs of said coils, said ventilation circuit comprising:
a cooling gas passage defined in at least one turn of each said coil of said end winding, said cooling gas passage extending from an inlet port in communication with the cavity on one longitudinal side of said turn to one of (1) a radial chimney defined through a plurality of the turns of the coil within said respective radial slot and (2) an exit port defined on the other longitudinal side

of said turn, said cooling gas passage extending along at least a portion of the longitudinal extent of said turn; and

wherein at least a portion of said cooling gas passage defines a wavy cooling path along a direction of cooling gas flow for enhanced heat transfer.

[c17] 17. A cooling gas ventilation circuit according to claim 16, wherein walls of said portion of said passage are sine wave shaped.

[c18] 18. A cooling gas ventilation circuit according to claim 16, wherein walls of said wavy cooling path are of substantially constant width.

[c19] 19. A cooling gas ventilation circuit according to claim 16, wherein at least a portion of a surface of said cooling gas passage is knurled so as to define a plurality of ribs for enhanced heat transfer.

[c20] 20. A cooling gas ventilation circuit according to claim 19, wherein said ribs are generally V-shaped having an apex and first and second legs, said legs being disposed downstream of said apex with respect to a cooling gas flow direction and being disposed at an angle with respect to a cooling gas flow direction.

[c21] 21. A cooling gas ventilation circuit according to claim 20, wherein said angle is between about 45 ° and 90 ° .

[c22] 22. A cooling gas ventilation circuit according to claim 16, wherein at least a portion of a surface of said cooling gas passage knurled so as to define a plurality of dimples for enhanced heat transfer.

[c23] 23. A cooling gas ventilation circuit according to claim 22, wherein said dimples are substantially hemispherically shaped.

[c24] 24. A cooling gas ventilation circuit according to claim 22, wherein said dimples are teardrop shaped having a rounded end and a pointed end, said pointed end being the downstream end of the dimple with respect to a flow direction of said cooling air.

[c25] 25. The cooling gas ventilation circuit of claim 16, wherein said cooling passage comprises a groove defined in a radially upper surface of said turn.

[c26] 26. A rotary machine comprising a rotor, a plurality of radial slots provided in said rotor, a plurality of coils respectively seated in said radial slots, said coils each comprising a plurality of radially stacked turns, said coils extending beyond a pole face of the rotor to form an end winding, cavities being defined between adjacent pairs of said coils, and a cooling gas passage defined in at least one turn of each said coil of said end winding, said cooling gas passage extending from an inlet port in communication with the cavity on one longitudinal side of said turn to one of (1) a radial chimney defined through a plurality of the turns of the coil within said respective radial slot and (2) an exit port defined on the other longitudinal side of said turn, said cooling gas passage extending along at least a portion of the longitudinal extent of said turn;

wherein at least a portion of a surface of said cooling gas passage is knurled to define at least one of ribs and dimples for enhanced heat transfer, and

wherein at least a portion of said cooling gas passage defines an undulating path for coolant flow for enhanced heat transfer.